Center Innovation Fund: LaRC CIF

Zero-Energy Ultrafast Water Nanofiltration System in Microgravity

Completed Technology Project (2016 - 2017)

Project Introduction

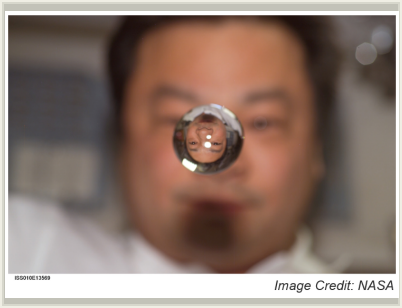
The goal of this program is to develop a water nanofiltration system that functions in microgravity for use during a long-duration human space exploration. The proposed nanofiltration system targets deep space crewed missions beyond low-Earth orbit (LEO) where it is impossible to launch fresh resupplies or carry sufficient mass and volume of life-sustaining equipment. Based on spontaneous surface-tension-driven flows, no external power is required to selectively transport water molecules through a nanostructured membrane. The speed of water transport through the membrane can be dramatically accelerated multiple orders of magnitude faster than prediction from conventional fluid-flow theory, while the confinement and electrostatic interactions lead to excellent salt rejection. The novelty of the microgravity filtration system includes zero-power consumption, ultrafast filtration, surface-tension-driven flow control in microgravity, excellent impurity rejection rate, lightweight, compact size, portability, recyclability and scalability.

Current water filtration methods include distillation and membrane-based technologies. Both methods require a significant amount of energy. For example, reverse osmosis (RO), an energy-efficient membrane-based process, requires a fair amount of energy to apply 800-1000 psi across membrane filters. NASA tested a forward osmosis bag (FOB) on the ISS in an effort to provide a more energy-efficient solution. Despite lower power consumption (@ 25psi), the FOB required long filtration times (6 hours per 60 ml of a treated water sample), since it solely relies on a slow diffusion mechanism. Given limitations of energy and speed, a highly efficient filtration system is desperately needed for successful implementation of long-duration, deep space human exploration missions within the next 20 years. To achieve low power consumption and high speed, a new type of water filtration system is being researched on the basis of surface-tension-driven flows across a nanostructured membrane in microgravity.

Anticipated Benefits

This technology would allow highly efficient, ultralight-weight, water filtration on the International Space Station (ISS).

The proposed highly efficient, lightweight, nanofiltration system could be a key component for portable life support systems and emergency escape systems during deep space human exploration beyond LEO.



Astronaut watches a sphere of water float between him and the camera, showing his image refracted, on the International Space Station (ISS). (Image credit: NASA)

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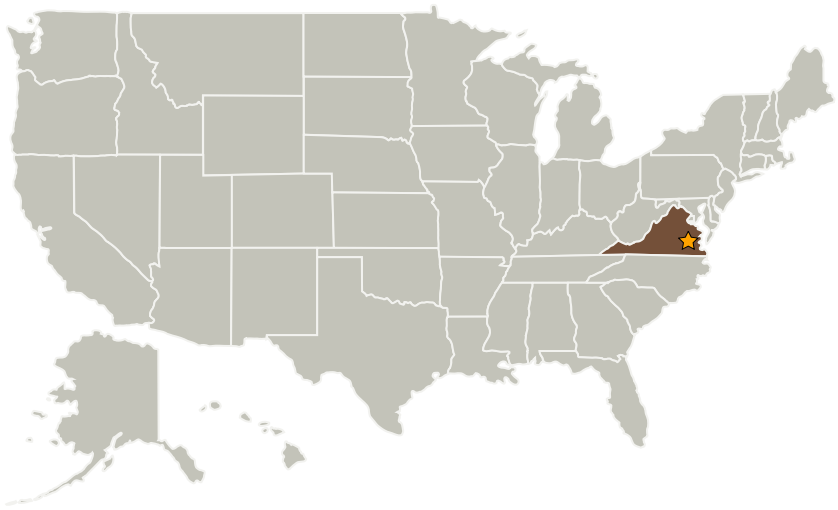

Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
National Institute of Aerospace	Supporting Organization	Academia	Hampton, Virginia

Primary U.S. Work Locations
Virginia

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Center Innovation Fund: LaRC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Julie A Williams-byrd

Principal Investigators:

Sang-hyon Chu
Cheol Park

Co-Investigators:

Catharine C Fay
John-andrew S Hocker

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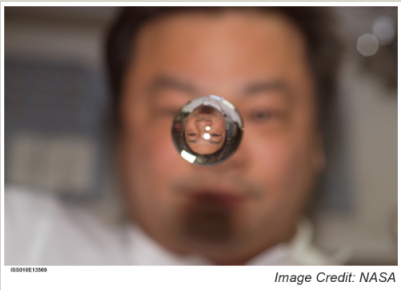
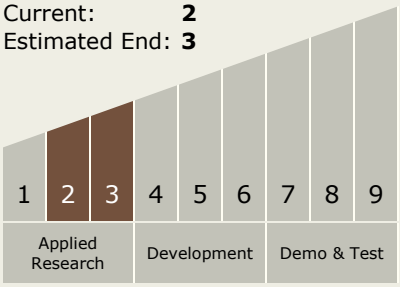
Images



Water in microgravity
Astronaut watches a sphere of water float between him and the camera, showing his image refracted, on the International Space Station (ISS). (Image credit: NASA)
(https://techport.nasa.gov/image/26109)

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.1 In-Situ Resource Utilization
    - TX07.1.3 Resource Processing for Production of Mission Consumables